In the Claims

1   1. (currently amended) A method for decoding an $[N, k]_q$ sparse transform

2   factor graph code using a soft-input cost function, <u>where k is a dimension of</u>

3   <u>the code, N is a number of symbols to be decoded, q is a number of elements</u>

4   <u>in an alphabet for the symbols of the code, and a number of input elements</u>

5   <u>of the sparse factor graph is M,</u> comprising:

6   a one-time initialization procedure; comprising:

7   constructing a sparse transform factor graph representation of

8   the code;

9   selecting an encoding method consistent with the

10   representation;

11   selecting a message-passing decoder method consistent with the

12   representation;

13   initializing messages of the selected decoder method according

14   to the soft-input cost function; and

15   an iterative decoding procedure, comprising:

16   updating messages according to message-update rules of the

17   selected decoder; <u>and</u>

18   outputting a code word when a termination condition is true,

19   and otherwise repeating the iteration of the decoding procedure.

1   2. (original) The method of claim 1, in which the code is a Reed-Solomon

2   code.

1   3. (original) The method of claim 1, in which the code is an extended Reed-

2   Solomon code.

1   4. (original) The method of claim 1, in which the code is a punctured Reed-

2   Solomon code.

1   5. (original) The method of claim 1, in which the code is a extended ternary

2   Golay code.

1   6. (original) The method of claim 1, in which the code is a non-binary code.

1   7. (original) The method of claim 1, in which the sparse transform factor

2   graph includes input-output factor nodes, each input-output factor node has k

3   input variables entering the node from the left, and k output variables exiting

4   the node from the right, and the input variables and the output variables are

5   related by $2k$ constraints, where k is a rank of the input-output factor node.

1   8. (original) The method of claim 7, in which the rank k is two.

1   9. (original) The method of claim 7, further comprising:

2   stacking and layering the input-output factor nodes.

1   10. (original) The method of claim 1, wherein the sparse transform factor

2   graph code is a fast sparse transform factor graph code.

1   11. (original) The method of claim 1, further comprising:

2   simplifying the sparse transform factor graph representation.

1   12. (original) The method of claim 11, further comprising:

2   generating a plurality of the simplified sparse transform factor graph

3   representations; and

4   combining the plurality of the simplified sparse transform factor graph

5   representations into a redundant sparse transform factor graph

6   representation.

1   13. (original) The method of claim 1, in which the message passing

2   decoding method includes message-update rules and belief-update rules.

1   14. (original) The method of claim 1, in which the messages are initialized to

2   zero.

1   15. (original) The method of claim 1, in which the iterative decoding

2   procedure further comprises:

3   determining a trial code word from the messages, the selected decoder

4   method and the encoding method;

5   determining a cost of the trial code word using the soft-input cost

6   function;

7   updating a tentative code word with the trial code word if the trial

8   code word has lower cost than the tentative code word; and

9   terminating by outputting the tentative code word when the

10   termination condition is true, and otherwise repeating the iteration of the

11   decoding procedure.

1   16. (original) The method of claim 15, in which an initial cost of the

2   tentative code word is infinity.

1   17. (original) The method of claim 15, in which the termination condition is

2   fixed number of iterations.

1   18. (original) The method of claim 1, further comprising:

2   combining the selected decoder with a with a different decoder.

1   19. (original) The method of claim 1, further comprising:

2   combining the selected decoder with a hard-input bounded-distance

3   decoder that uses thresholding.

1   20. (original) The method of claim 1, further comprising:

2   concatenating the selected decoder with a different soft-input decoder.

1   21. (original) The method of claim 10, in which the fast sparse transform

2   factor graph has M q-ary input and output variables, and where N input,

3   internal, and output transform variables in the fast sparse transform factor

4   graph are connected to soft-constraint factor nodes, and $M-k$ of the input

5   variables are connected to factor nodes that constrain the input variables to

6   equal zero.

1   22. (original) The method of claim 21, in which the fast sparse transform

2   factor graph includes hard-constraint equality constraint factor nodes to copy

3   the internal transform variables that are connected to the soft-constraint

4   factor nodes.